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ABSTRACT

Participants in a conference held by the National Center for Research in Vocational Education discussed the relationship between academic and industry skill standards and reached consensus in several central areas. Arguments for better coordination between academic and technical standards were as follows: integrated skills are needed in new, more demanding workplaces; relating learning to work can strengthen academic learning; given workplace demands for better academic skills across all occupations, increasing the rigor of academic preparation for all students is important; and by working together, academic and vocational educators and employers can strengthen both sets of standards. Academic and industry skill standards had been developed largely in isolation from each other. Workplace applications offered by the academic skills were rarely explicit. Industry skill standards included academic standards as abstract lists of skills unconnected to their use in the workplace. Despite consensus that standards should be set at a high level, most academic standards offered no absolute normative benchmarks against which to measure student performance and were set by educators based on their judgment about what students should know. The academic component of the industry skill standards called for skills that could be achieved well short of high school graduation. The most significant area of overlap between the two sets of standards was their use of process-oriented skills. Seven recommendations were made for further development of standards and research. (Contains 32 references) (YLB)

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Integrating Academic and Industry Skill Standards

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INTEGRATING ACADEMIC AND INDUSTRY SKILL STANDARDS

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EXECUTIVE SUMMARY

Introduction

This report focuses on the relationship between academic and industry skill standards and assesses the current state of coordination between them. It also explores how better integration between the two sets of standards could strengthen both and could ultimately have a positive influence on education as a whole. Although not a conference summary, this report draws on the experiences and discussion from a 1996 conference sponsored by the National Center for Research in Vocational Education. The conference brought together individuals who had worked on developing the two types of standards to discuss the potential for integration and how that integration could take place. The conference and the content of this report focus on the academic standards developed in five disciplines: mathematics, English/language arts, social studies, science, and history. Industry skill standards are represented by the following skill standards pilot projects sponsored by the U.S. Departments of Education and Labor: electronics, retail, bioscience, photonics, automotive repair, health care, and metalworking. The U.S. Departments of Education and Labor sponsored two projects in the electronics industry and both sets of skill standards were represented at the conference.

Why Coordinate Academic and Industry Skill Standards

The paper presents four broad arguments for better coordination between academic and technical skill standards. First, educators, policymakers, and employers have emphasized the value of creating stronger connections between academic and vocational education for several years. Integrated skills are needed in new, more demanding workplaces and provide better pedagogic and social opportunities for all students and educators. Second, research has increasingly shown that relating learning to work can strengthen academic learning by giving a coherence to academic studies that is difficult to create when subjects are taught independently or in the abstract. Third, given that the workplace now demands better academic skills across all occupations, increasing the rigor of academic preparation for all students is especially important. Fourth, by working together, academic and vocational educators and employers can strengthen both sets of standards. At the same time that educators often do not possess a strong understanding of the workplace, employers and workers are not in the best position to evaluate the academic content of the skills they need. A strong working relationship between educators and

employers in developing skill standards eliminates potentially misleading messages delivered through standards.

The Current State of Coordination

Although slowly beginning to change, academic and industry skill standards have been developed largely in isolation from each other. To be sure, most industry skill standards make references to academic standards and most of the academic standards call for some types of work applications. In general, however, the workplace applications offered by the academic skills are rarely explicit. Students are sometimes offered ad hoc or isolated examples of applications, but they can meet the academic standards without necessarily being able to apply their academic skills to realistic work-related problems. Similarly, industry skill standards often include academic standards but do so as abstract lists of skills that are left unconnected to their use in the workplace.

The required performance levels of both academic and industry-related skills also needs much more attention. Even though there is a broad-based consensus that standards need to be set at a high level, most of the academic standards offer no absolute normative benchmarks against which to measure student performance. Most of the academic standards were set by educators based on their judgment about what students should know, usually to proceed to the next level of education. These judgments were not based on objectives from outside the disciplines or the education system. While the industry skill standards do call for academic skills, those academic standards were usually set very low. For the most part, the academic component of the industry skill standards call for skills that can be achieved well short of high school graduation. Employers, however, may not understand the advanced academic skills that their standards require. This lack of understanding and the potential for misrepresented academic skills further supports the need for collaboration with educators so that actual academic competence can be determined.

The most significant area of overlap or common ground between the two sets of standards was their use of process-oriented or SCANS-type skills. Both types of standards call for strengthened problem-solving, teamwork, inquiry, and communication skills. They emphasize the use of a variety of sources of information to investigate issues and arrive at answers and solutions and they advocate the use of different means and media to

communicate those solutions. Nevertheless, recognition of consistent skills across the standards is only a first step toward integration. Defining and evaluating crossfunctional skills such as these generic skills offers many opportunities for academic and industry skill standards developers to work together. First, standards setters must dissect the generic components from specific components of these process skills. Ultimately, generic standards will only be meaningful to the extent that they can be assessed so both academic and industry groups have a large stake in the success of those efforts.

Using Standards To Develop Projects and Curricula that Integrate Academic and Vocational Instruction

The conference was organized in such a way as to give employers and academic and vocational educators a chance to work together on specific pairs of academic and industry skill standards. For example, the developers of the English standards were paired with representatives of the standards for retailing. As a group, they were charged with reviewing each other's standards, discussing strengths and weaknesses, and identifying opportunities for using standards to promote integrated instruction and curriculum. Despite initial skepticism, the group did develop several projects. For example, the English standards call for mastering critical writing that contrasts and compares alternative points of view. The retailing standards expect students to understand alternative approaches to marketing. The retailing teachers asked whether having retailing students write an essay contrasting the different marketing strategies of two major corporations—Nike and Reebok—would be an acceptable means of addressing the English standard. Without hesitation, the English teachers endorsed that approach. Other sessions at the conference and at workshops organized by NCRVE held since the conference have yielded other similar examples. Many of the participants at the conference and at the workshops were convinced that this approach had great potential to strengthen both academic and vocational education.

Recommendations

The report ends with seven recommendations that can be used to guide the further development of standards. In addition, the recommendations can serve as a framework for further research.

1. **Promote the continued collaboration among academic and vocational teachers and employers both in the development of standards and in the use of standards to develop curricula.**

   Experience during and after the conference indicates that this collaboration is possible and useful. To the surprise of many of the participants, this first opportunity to interact with a different set of players, led to the discovery of a great deal of common ground. In addition, collaboration has several benefits. First, it can improve the accuracy and relevance of the standards. Second, it can lead to increased motivational and pedagogic benefits as the standards become more embedded in broad, coherent, and authentic applications. Third, it can foster a better understanding of the workplace to help academic teachers plan curricula that would be both academically sophisticated and more closely related to the needs of the workplace.

2. **Improve the definition and measurement of the levels of academic skills within the industry skill standards, including more emphasis on differentiating between the standards for entry-level and higher-level jobs within the same area. Ideally, industry skill standards should be able to refer explicitly to appropriate academic standards.**

   Even though employers indicate that they prefer to hire high school graduates, for the most part, the academic skills contained in their industry skill standards can be obtained with less than a high school degree. This was clearest for mathematics, but less obvious for science. Academic skills from the other disciplines were often defined in the industry skill standards in such general terms that no precise level could be discerned. Employers may be incorrectly specifying the academic content of skill needs because they do not understand the specific benefits that students gain from high school. This is the type of problem that improved collaboration could address. If industry skill standards appropriately indicate the academic skills

required for entry-level work, students and teachers using the standards must focus on the higher-level skills needed for subsequent career advancement.

In many cases, the academic components of the industry skill standards provide little guidance to teachers and students because they are stated in vague and abstract terms. Much work needs to be done in defining the academic content of the industry skill standards.

3. **Develop academic standards so that meeting those standards will indicate that a person is able to apply the relevant academic skills outside the classroom in the workplace and in the community, and so that they specify levels of academic achievement.**

Although called for in the original Goals 2000 legislation, the academic standards lack an organization that is equivalent to the National Skill Standards Board to provide a forum for reevaluating and developing a systemic focus for the standards. Some conference participants criticized the academic standards for being too geared toward preparing students for the next level of education as opposed to using their skills for work-based activities and cultural or civic duties. Students should only be able to meet academic standards by applying them outside of the education system through activities such as industry-based projects or scenarios.

Although this report has criticized the industry skill standards for calling for rather low levels of academic achievement, some of the academic standards fail to specify levels of achievement. The English standards offer the best example. We have suggested that the industry skill standards refer explicitly to academic standards in defining required academic skills, but this will be impossible if levels are not defined.

4. **Encourage the use of standards to promote the integration of academic and vocational education. Create a clearinghouse for curricula and projects developed through collaborative use of academic and industry skill standards.**

Better coordination between the two sets of standards should be part of a strategy to achieve the broader goal of the integration of academic and vocational education. Standards can be used to create projects and curricula that bring academic and

work-related material together in an interesting manner that does not compromise the level and sophistication of the standards from either area. Such an integrated approach to teaching and learning can strengthen the academic base of work-related skills and can provide a context and motivation for learning academic skills.

5. **Systematically experiment with different approaches to coordination of the two sets of standards.**

Although few would argue against better coordination between academic and industry standard setters, little consensus has emerged regarding the optimal form of integrated standards or the infrastructure to coordinate groups of standard setters. Conference participants discussed linking existing standards through crosswalks that identify the academic content of different industry or occupational skills—standards in bioscience and automotive repair included such crosswalks. Participants agreed that crosswalks were useful, but only a first step. Nevertheless, this approach will not necessarily generate the benefits that could derive from closer coordination in the development of both sets of standards. Crosswalks identify the academic content of industry-related skills and illustrate the use of academic skills in industry contexts, but we have suggested that both sets of standards would be strengthened if the developers closely worked together. This would not necessarily happen if the efforts at integration were limited to the development of crosswalks for existing sets of standards that were developed independently.

A more difficult approach would be to use academic and generic skills to develop specific industry tasks, scenarios, or complex examples. This natural integration of academic and vocational material can lead easily to curricula and projects that can be used by teachers. A more comprehensive approach involves designing academic and industry skill standards together and combining both industry needs and a more comprehensive view of an academic program including attention to the academic foundations required for advancement beyond entry-level positions.

6. **Use the development of standards and the collaboration among standard setters to refine our understanding of generic (or SCANS) skills and to develop better means to teach and assess them.**

Academic and industry skill standards overlapped most in the area of generic or process skills. Since generic skills vary in different contexts, it is important to go beyond the general descriptions and language of SCANS and understand the nature of generic skills in the different disciplines and industry settings. Without this specific information, it is difficult to translate the need for skills into a process that has meaning and application in the classroom.

7. **Focus on the development of appropriate teaching strategies and associated curricula and materials and on effective ways to prepare teachers to use those strategies.**

Standards can be a means to define and signal both required skills and important teaching tools. Current pedagogy has been organized around compartmentalized curricula that preserve sharp distinctions among the disciplines, between academic and vocational learning, and even among different vocational areas. The integration of academic and vocational education, the development and use of standards, or combining an integrated educational approach have had a strong educational tradition in this country. A great deal of work remains to be done to determine an optimal form for the standards and the best ways to use them for teaching and learning. To be effective, reforms must gain a better understanding of the most appropriate teaching strategies for the standards and how to most effectively train teachers to use those new strategies.

TABLE OF CONTENTS

Acknowledgments i
Executive Summary iii
Introduction 1
Sources of Information 2
The Importance of Better Coordination Between
Academic and Industry Skill Standards 3
The Current State of Coordination Between Academic
and Industry Skill Standards 7
Work Connections in the Academic Standards 8
Academic Skills in the Industry Skill Standards 11
The Academic Level of Industry Skill Standards 12
Generic, Process, or SCANS Skills 15
Using Standards To Facilitate the Integration of Academic and
Vocational Education 19
Conclusions and Future Directions 23
References 31

INTRODUCTION

During the last decade, education reformers have increasingly emphasized the importance of standards. Although there remains a great deal of controversy about the nature and scope of standards, there is consensus that students should be held to high standards in whatever area they are pursuing.[1] Moreover, standards have become a central aspect of reforms in both academic and vocational education. Academic teachers have developed standards in many academic subject areas and educators and employers are working together to develop industry and occupational skill standards. Until recently, however, there has been little interaction and communication between those who have been working on academic standards and those working on industry skill standards.

This report focuses on the relationship between the two sets of standards. It asks what the current relationship is between them and whether there should be more interaction and coordination. It also makes some suggestions about what that coordination might look like.

The first section describes the source of the information used in the report. Much of that information was developed at a conference convened in 1996 by the National Center for Research in Vocational Education. Although this report is not a summary of the conference, many of the arguments, conclusions, and recommendations were developed and discussed at the conference. The subsequent section argues that there are important educational reasons to coordinate academic and industry skill standards and that it is particularly important that the groups that are developing the two sets of standards work together. The report then assesses the current state of coordination between academic and industry skill standards and identifies the extent to which industry or work-related materials are incorporated into academic standards and the extent to which academic skills appear in industry skill standards. Examples are then presented that show how academic and industry

[1] Reformers generally believe that standards will provide a superior way to regulate the design, quality, and effectiveness of education. Rather than judging the adequacy of an education based on the number and types of courses taken or "seat time," education will be judged on outcomes. According to this view, requiring students to "meet high standards" is the most direct way to assure that they accumulate the knowledge and learn the skills needed to function effectively in the modern society and workplace. Standards will give the employers and educators who hire and train graduates a much more concrete idea of individual capabilities. Standards will also provide students with more concise information regarding the skills and knowledge necessary to attain a particular level of education or enter a particular career path (see Marshall & Tucker [1992] for a summary of this argument). Despite widespread support, there remains a great deal of controversy about the development and implementation of standards at the national level.

skill standards can be used to develop rich curricula that integrate academic and vocational education. The report ends with some suggestions about how academic and industry skill standards could be coordinated to strengthen both the standards themselves as well as education in general.

SOURCES OF INFORMATION

As mentioned, much of the information presented in this report is based on a conference convened in 1996 by NCRVE to discuss the relationship between academic and industry skill standards. The purpose of the conference was to bring together people who had worked on the two types of standards to analyze the relationship between the standards; make recommendations regarding how they should interact; and, ultimately, determine how both sets of standards should be designed and used to improve education.

The conference focused on standards developed for seven industries and five academic disciplines. These sets of standards in effect represent the sample that is considered in this report. The majority of the conference participants had been directly involved in developing these particular academic and industry skill standards.[2] Much of the discussion at the conference was based on an examination and analysis of the actual published standards.

The conference focused on the standards developed in electronics, retail, bioscience, photonics, automotive repair, health care, and metalworking. Although they represent seven industries, the conference actually considered eight industry projects since two sets of standards were developed for the electronics industry. The eight industry projects were chosen so as to include a wide variety of industries and approaches to standards design. These were chosen from among 22 industry skill standard pilot projects started in 1992 and 1993 with funding from the U.S. Departments of Education and Labor. Most of these projects set out to define the knowledge and skills required for "entry-level" workers in the relevant industries, although some projects did develop standards for higher-level workers.

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[2] Participants also included experts on skills and assessment; representatives of the U.S. Departments of Education and Labor; and members and staff of the National Skill Standards Board.

The conference examined academic standards in mathematics, English/language arts, social studies, science, and history. Over the past several years, educators have developed frameworks for standards for these disciplines. These standards are meant to define what students at different grade levels should be able to master in each of the academic subject areas, although some of the frameworks have not defined grade levels or assessments at this point. The National Council of Teachers of Mathematics (NCTM) developed the first set of standards in 1989. Since then, frameworks have been developed by the National Council of Teachers of English (NCTE) and International Reading Association (English/language arts standards), the National Council for the Social Studies (NCSS) (social studies standards), the National Research Council (science standards), the National Center for History under the guidance of the National Council for History Standards (history standards), and several others.

The report summarizes the central areas of consensus that emerged from the conference, although it does not necessarily reflect the views of all the conference participants. The report also relies on additional material published before and after the conference. Since the conference, NCRVE has conducted several workshops in conjunction with its publication *Getting to Work*, which includes curriculum materials designed to help teachers integrate academic and vocational education. Building on the discussions and experience at the conference, the *Getting to Work* workshops have used academic and industry skill standards to develop projects and curricula that integrate academic and vocational education. Some of the examples generated at these workshops are used in this report.

THE IMPORTANCE OF BETTER COORDINATION BETWEEN ACADEMIC AND INDUSTRY SKILL STANDARDS

Why should we care about the relationship between academic and industry skill standards? One could argue that they serve different purposes. Academic standards define what all educated citizens should know in particular subject areas while industry skill standards indicate what skills are necessary to work effectively in particular occupations or industries. Education reformers are often reluctant to design curricula explicitly to prepare young people for work because many believe that the short-term needs of employers can be

in conflict with the broad goals of education. Educators emphasize that these broader goals include the development of the capacity for independent thinking and a spirit of questioning and inquiry.[3] According to this view, an education designed primarily to prepare students for work might not include subjects such as the humanities, art, music, and history. Instead, it would include only simplified and less rigorous aspects of mathematics and science. A focus on work preparation would, therefore, result in a narrow and impoverished education. Education reformers who are suspicious of industry skill standards see work preparation and broader educational objectives as fundamentally conflicting goals. In contrast, the call for better coordination between academic and vocational skills is based on the argument that better coordination and more interaction among the groups developing those standards could strengthen both academic preparation and preparation for work. The following paragraphs present four broad arguments for better coordination between the two sets of standards.

First, many educators and policymakers, especially those involved with vocational education, have argued over the past several years that it is important to strengthen the connections between academic and vocational education (Grubb, 1995). The traditional separation between these two forms of education has been judged to have negative social and pedagogic effects. The goal of integrating academic and vocational education has now been articulated in important pieces of federal education legislation including the 1990 reauthorization of the Perkins Vocational Education and Applied Technology Act and the 1994 School to Work Opportunities Act. Changing technology and work organization have created more sophisticated demands for jobs that have traditionally employed graduates of vocational education programs. Wages for lower-skilled jobs requiring little education have fallen significantly in the last two decades, and higher levels of education are now required for access to jobs with wages adequate to support a family. In the past, many employers admitted that they wanted entry-level workers who were prompt and would follow orders. Now, however, many state that they want workers who can solve problems, work in more uncertain and less well-defined circumstances, and take initiative and responsibility (Bailey, 1995; Murnane & Levy, 1996; Stasz, Ramsey, Eden, Melamid, & Kaganoff, 1996). These are the types of activities previously expected from workers who had a good academic educational foundation and who had often been to college. This suggests that academic preparation for workers at many levels has become more important.

[3] See Bailey and Merritt (1997) for a discussion of the tension between education reform and industry skill standards.

Second, there is a substantial body of cognitive research which suggests that relating learning to work applications (or general applications outside of school) can strengthen academic learning. For example, work applications can provide important motivational benefits by showing students how the skills that they are learning are actually used in the workplace and in society at large. The purpose of the application here is not necessarily to prepare the student for a particular job, but, rather, to use the industry or occupational context to motivate a deep understanding of the relevant academic skills (Raizen, 1994; Resnick, 1987). Furthermore, a broad industry context can offer opportunities to combine and integrate different academic disciplines. Rather than using piecemeal or ad hoc examples from the "real world" to illustrate the use of particular academic skills, teachers can combine aspects from many disciplines to design projects and curricula organized around industry or occupational themes. For example, agriculture can be used to motivate learning in every subject. Applications to mathematics and the sciences are obvious, but it is also not difficult to come up with applications from literature, social studies, or history. Well-chosen experiences in an industry context can give a coherence to the academic studies that is difficult to create when subjects are taught independently and in the abstract. Although at first this may appear to be a pedagogic issue, the substantive content of what students are taught is also fundamental. In response to this, new curricula are being developed that encourage sophisticated applications to problems and issues outside the classroom and that recognize the importance of interdisciplinary thinking (Vickers, 1997). Thus, sets of academic and industry skill standards that remain isolated from each other will hardly encourage and may hinder new approaches to teaching. Certainly, coordinating the development of academic and industry skill standards would at least offer many opportunities to pursue an integrated approach. From this perspective, both sets of standards could be improved.

Third, many jobs indeed require sophisticated academic skills and, thus, preparation for these types of jobs is consistent with a rigorous academic education. Changing economic and technological factors also influence those required skills. For example, knowledge of probability and statistics has become much more important for many jobs, even though these branches of mathematics are not traditionally emphasized in high school mathematics courses. Forman and Steen (1995) have argued that mathematics used in the workplace today is much more likely to involve sophisticated applications of more elementary mathematics principles than the elementary applications of more complex mathematics that characterize traditional curriculum materials. If this is true, educators and

employers, working together, could develop a mathematics curriculum that would be more oriented towards the actual use of mathematics in the workplace, but would be equally as sophisticated as the current curriculum. Thus, better coordination between the development of academic and industry skill standards would increase the opportunities to deepen the academic curriculum in ways that are also consistent with trends in the workplace.

Fourth, while educators are likely to have a poor understanding of skills used in the workplace, employers or even workers are often not in the best position to evaluate the academic content of the skills that they need. For example, employers might believe that their workers do not need to know algebra and at the same time complain that their employees cannot work effectively with spreadsheets. Thus, they fail to understand the algebraic basis of many spreadsheet operations. Alternatively, employers may think that their workers need only simple mathematics without realizing that modern quality control methods depend on a sophisticated understanding of statistics. Forman and Steen (1995) argue that much work-related mathematics involves sophisticated and advanced applications of basic mathematical principles, yet employers may notice only the basic principles. By working together, employers might realize that the mathematics that they need is more complicated than they thought and educators may begin to understand that work-related applications offer greater opportunities to teach sophisticated mathematics than they might have expected.

Moreover, industry skill standards that do not communicate the high levels of academic performance required for occupations in their industries can give misleading messages to young people. As we shall see later, an examination of the industry skill standards suggests that some (but not all) of the industry skill standards set expectations for academic skills that are lower than those required for graduation from high school. Nevertheless, employers still say that they want high school graduates. Thus, there must be some misconceptions or miscommunications if employers prefer to employ high school graduates yet define specific skill requirements at a lower level indicating a satisfaction with skills learned by the tenth grade.

Therefore, the continued division between academic and industry skill standards has several disadvantages. It promotes a separation between academic and vocational skills at a time when many educators and employers are increasingly challenging that separation. It threatens the accuracy of both sets of standards—employers may not have a good

understanding of the academic content of the skill that they want and educators can lose touch with the central applications of what they are teaching. In addition, it forecloses the opportunities to create standards that could deepen both academic learning and preparation for work.

THE CURRENT STATE OF COORDINATION BETWEEN ACADEMIC AND INDUSTRY SKILL STANDARDS

Although the standards movement has permeated the academic disciplines and work-related areas, so far academic and industry skill standards have been developed almost entirely independently of each other. While some of the academic standards make reference to "skills needed for the workplace" or other "real-world" phenomena and all of the industry skill standards developed by the pilot projects refer in some way to required academic skills, in the past there has been almost no coordination across the academic-industry divide. For the most part, the representatives of the academic and industry skill standards groups who attended the conference were completely unknown to each other before the conference.

The isolation of the two groups is slowly beginning to change. In late 1995, the National Governors Association convened a conference in Kansas City that was attended by a variety of individuals working on school reform and industry skill standards as well as a small number of individuals who had worked on the academic frameworks. In late 1996 and 1997, several groups have worked towards more coordination. NCTE and the International Reading Association are planning to publish a volume that will extend the discussion of their standards into the areas of workplace literacy, career education, and school-to-work. In their Call for Papers, NCTE (1997) has requested essays that "reflect on the changing definitions of literacy and the need to build relationships between educators and workplace communities." In early 1997, the National Skill Standards Board (NSSB)[4], the U.S. Department of Education's Office of Vocational and Adult Education, and the U.S. Department of Labor's Education School-to-Work Office initiated a project called "Building Linkages." This is explicitly designed to develop three-way linkages or

[4] The Goals 2000: Educate America Act established the National Skill Standards Board in 1994 to coordinate the development of voluntary national industry skill standards.

crosswalks between the academic and industry skill standards in various states and selected national industry skill standards. The projects now sponsored under the Building Linkages auspices are expected to build multistate partnerships that promote linkages between academic and industry-recognized skill standards at the state level. The consortia members will work with local businesses, labor organizations, and education and training agencies to explore effective methods of incorporating academic and technical/industry skill standards into school-to-work systems.

While these developments are encouraging, they are only beginning and have so far had little effect on the standards themselves. There was no consensus at the conference about the particular form that more coordinated standards would take. Indeed, there was some conviction that no one form would work for everything. In this section, we shall look at some of the standards considered at the conference to develop an understanding of the *current* relationship between academic and industry or occupational skill standards as they have already been written.

Work Connections in the Academic Standards

The academic standards examined at the conference take a variety of forms.[5] Some were more specific about the substance of the knowledge that students were expected to learn. English/language arts standards, at one extreme, focused on process-oriented skills. The entire set of standards consisted of twelve statements printed on one page. For example, Standard #5 states that "Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes" (NCTE and International Reading Association, 1996, p. 3). The standards developers refrained from specifying the types of literature that students would be expected to read. In contrast, the history standards specify the particular knowledge about history, for example, stating that the students should know about the "massive immigration after 1870 and how new social patterns, conflicts, and ideas of national unity developed amid growing cultural diversity" (National Center for History in the Schools, 1996, p. 104). The academic standards gave little direct mention of skills needed for work. Clearly, the authors of the standards did not conceptualize their mission

[5] All of the academic standards were taken directly from the most recent national standards publications. The actual documents are included in the References at the end of this report.

as preparing students for work in any direct way. Indeed, traditional academic programs have not emphasized concrete applications. While there are aspects of the standards that refer to work-related situations or are directly applicable to work, these links are usually not made clear.

The mathematics standards do include many references to work. The authors of the standards suggest an emphasis on word problems and the use of "real-world problems to motivate and apply theory" (NCTM, 1989, p. 126). The following is an example of the type of problem that they encourage:

> A container manufacturing company has been contracted to design and manufacture cylindrical cans for fruit juice. The volume of each can is to be 0.946 liters. In order to minimize the production costs, the company wishes to design a can that requires the smallest amount of material possible. What should the dimensions of the can be? (p. 134)

The authors argue that this simple work application can be approached at many levels of sophistication and can serve to illustrate a wide variety of mathematical techniques and concepts. The Mathematical Sciences Education Board has put together a collection of work applications that illustrate the sophisticated use of many different levels of mathematics in realistic settings.

Usually the standards do not have an explicit emphasis on work situations, although they sometimes do offer applications to work. For example, the high school performance expectations for social studies require that students, "Describe and compare how people create places that reflect culture, human needs, government policy, and current values and ideals as they design and build specialized buildings, neighborhoods, shopping centers, urban centers, industrial parks, and the like." And, "Propose, compare, and evaluate alternative policies for the use of land and other resources in communities, regions, nations, and the world" (NCSS, 1994, p. 118). These types of skills can potentially have wide applications in many jobs. The history standards also include issues that may have applications to work. For example, history students are expected to understand "the connections among industrialization, the advent of the modern corporation, and material well-being" (National Center for History in the Schools, 1996, p. 104).

All of the standards documents include material that suggests how the standards might be used and, in some cases, this points to activities or projects that have relevance to

work. For example, the language arts standards describe an elementary level project that would culminate in a class presentation and associated activities about water purification after the pollution of a community's water supply. In this project, the students and the teacher decide together on the best sources of information, including books, print media, interviews, or other sources. The students then prepare written material and a presentation including a debate on the best remedy for the problem (NCTE and International Reading Association, 1996, pp. 50-51).

In general, the standards for each of the disciplines include many skills that have potential applications in the workplace. Nevertheless, these applications are rarely made explicit. Thus, while students who meet the academic standards may have learned academic skills that are potentially useful at work, many students will never have had opportunities to apply them to realistic work-related problems. And indeed, many employers complain that workers often do not seem to be able to apply their school-learned knowledge. Research also suggests that there is often weak transfer of academic knowledge to what should be relevant applications outside of the classroom (Berryman & Bailey, 1992).

Moreover, this is related to a further problem with the academic standards. While most educators, parents, and policymakers generally favor "higher standards," there is no absolute normative measure against which to set the standards. What will a student be able to do if they meet those standards that they would not be able to do if they failed to meet them? Most of the academic standards were set by educators based on their judgment about what students should know, usually to proceed to the next level of education. For the most part, those judgments were not based on objectives from outside the discipline or the education system. To be sure, preparation for work is only one of several educational objectives; nevertheless, it would be useful to have more conscious discussion of work applications (as well as cultural and other applications) as part of the general discussion of the intent and design of academic standards.

Academic Skills in the Industry Skill Standards

The industry skill standards developed by the pilot projects represented a wide variety of designs and forms.[6] At one extreme are skill standards that simply list all of the tasks that workers are expected to be able to perform for the relevant occupations. No particular work context is included. While academic skills may be necessary, these are also simply listed. At the other extreme are standards that focus on the critical functions required for the job and define them within the context of the industry. Success at the job (and achieving the standards) requires that the individual be able to carry out those functions. Particular academic skills are embedded within those functions. In these standards, the academic and industry skills are integrated within the industrial context.

Academic skills in various forms appear throughout the industry skill standards. Some standards simply call for knowledge of academic skills. For example, the Electronic Industries Foundation (EIF) standards suggest that entry-level electronic technicians need to be able to "simplify and solve algebraic expressions and formulas" to "use properties of exponents and logarithms" (Electronic Industries Association and Electronic Industries Foundation, 1994, p. 5-3). They must also "understand fundamental principles of mechanics," "understand fundamental principles of hydraulics," and demonstrate many more proficiencies in physics (p. 5-3). But these are very general standards and no level of knowledge is specified. Other standards tie the academic skills to particular work tasks. For example, the National Automobile Technician Education Foundation (NATEF) (1995) technical tasks lists include the following: "Add two or more whole numbers, fractions, or decimals to determine component conformance of multiple measurements with the manufacturer's specifications" and "Use Centigrade or Fahrenheit measurement scales to determine the existing temperature of substances such as a coolant or lubricant" (p. 1). The NATEF standards also include a "crosswalk" which lists academic skills such as "calculates/evaluates mean/median/mode" and then indicates which specialty areas make use of these skills. This particular academic skill is used in the "electrical" specialty area (p. 1).

The standards developed by the American Electronic Association (AEA) include three components, one of which is referred to as the "foundation for workplace success." These include academic skills such as communication skills that include reading, writing, listening, and speaking/presenting. Mathematics skills are considered to be those used "in

[6] Bailey and Merritt (1995) discuss alternative forms of industry skill standards in detail.

everyday business situations" such as "estimating discounts, monitoring expenditures, using statistical process and control procedures" (AEA, 1997 [brochure])

The bioscience standards explicitly tie academic skills to a series of complex "scenarios" which must be mastered by the students. For example, Scenario 13 is stated as follows:

> You are responsible for following the protocol for purifying your company's product. Demonstrate the steps you take in product purification.
>
> *The 2 liters of the crude product has a calculated yield of 10 grams per liter. You expect an 80 percent yield. After running the column, you calculate the purified total sample yield as 22 grams per liter.* **Show how you would handle this result.** (Education Development Center, 1995, p. 39)

In the "scenarios" developed in the bioscience standards, the academic skills are embedded in the tasks themselves rather than appearing as separate lists. The document describing the bioscience standards then lists specific academic and industry-related skills that are illustrated by each scenario (Education Development Center, 1995).

Thus, academic skills are clearly called for in the industry skill standards, although in most cases, the standards simply list at an abstract level some required academic skills. Even in the most sophisticated cases, the academic skills are defined in service to the required industry knowledge. Therefore, there is no comprehensive coverage of academic knowledge, nor did anyone expect there to be. Until recently, there has been no attempt to coordinate the industry skill standards with the academic frameworks or to specific curricula. Moreover, the levels of academic skills suggested by many of the industry skill standards tend to be rather low—often significantly below the high school graduation level.

The Academic Level of Industry Skill Standards

For the most part, the academic component of the industry skill standards could be met without achieving a grade 12 level of competence in a particular academic subject. Mathematics provides the clearest example.

According to mathematics experts who attended the conference, with the exception of photonics (which recommends two to three years of high school mathematics), virtually

all the mathematics specified in the seven sets of industry skill standards examined correspond to about two years of study at the level of middle school mathematics. The specified mathematics includes ratios, graphs, formulas, geometric calculations, and elementary statistics. However, in many more traditional curricula, these topics are spread out over grades 7-10, interspersed among many other topics (e.g., algebraic manipulation and geometric proofs) that are not listed in the industry skill standards. Furthermore, high school graduates who meet only the mathematics requirements outlined in the industry skill standards examined at the conference would require two or three remedial courses before being qualified to enroll in credit-bearing college-level mathematics courses.

The industry skill standards may also present an inaccurate picture of the level of academic skills required. For example, the photonics standards, the most mathematically advanced set of standards examined at the conference, recommend a curriculum whose mathematics component takes four years to accomplish what university-bound students routinely do in three years. In particular, Algebra II is listed as a senior course based on three years of preparation, whereas both the traditional and standards-based curricula expect Algebra II to be completed at the end of the junior year. This recommendation suggests that the curricula most appropriate for future photonics technicians is not as challenging as a typical college preparatory program, thus sending a dubious message about what students should be expected to learn (Center for Occupational Research and Development [CORD], 1995).

The level of academic science called for by the industry skill standards may be slightly higher, although in most cases the EIF standards are so general that it is difficult to assign them a level. For example, the standards for the electronic industry call for "proficiency in physics," which includes understanding the fundamental principles of mechanics, pneumatics, hydraulics, and electricity (Electronic Industries Association and Electronic Industries Foundation, 1994). Students may have a brief overview of some of this material in middle school, however, the minority of high school students who do take physics usually take it in their junior or senior years. The metalworking standards call for an understanding of "material properties" (National Tooling and Machining Association, 1994, p. 15) and the health care standards suggest that workers must be able to "apply knowledge of life sciences, such as biology, chemistry, physics, and human growth and development" (Far West Laboratory, 1995, p. 15). Biochemistry, microbiology, molecular biology, and organic chemistry are included in the list of "skills, knowledge, and

attributes" called for in the bioscience standards (Education Development Center, 1995, pp. 117-120). In this case, mastery of these disciplines would not be achieved until college. Still, these standards are so vague that they provide little guidance to students and teachers (How much organic chemistry should a prospective bioscience worker learn?). In general, however, the science educators at the conference, to some extent in contrast to the mathematics educators, did not emphasize the low levels of academic skills specified by the industry skill standards.

Defining the levels of English, social studies, or history specified in the industry skill standards is even more difficult. For the most part, there was little mention of social studies or history although the health standards did call on workers to "be aware of the history of health care" (Far West Laboratory, 1995, p. 15). Not surprisingly, none of the industry skill standards called for knowledge of the literature or literary analysis that make up much of the traditional language arts curriculum. However, most industry skill standards did call for writing and communication skills that students would be expected to learn in English, social studies, and history courses. For example, the metalworking standards include "reading, writing, speaking, and listening" and the health care standards suggest that workers need to be able to "read and write, including charts, reports, and measures" (National Tooling and Machining Association, 1994, included in all matrices; Far West Laboratory, 1995, p. 15). It is, therefore, impossible to determine required levels of achievement in these fields from the published standards. This is further complicated because the English standards, for example, do not specify levels of achievement. On the other hand, certainly, an effective education system would teach students to "read, write, speak, and listen," long before the end of high school, although these skills can be improved significantly with more education.

Thus, to the extent that levels of academic achievement are defined, the industry skill standards tend to call for skills that can be achieved well short of high school graduation. The case is clearest for mathematics, but less so for science. On the other hand, one conclusion to emerge from this exercise is that most of the industry skill standards groups failed to specify the levels of academic skills required in industry contexts. Calling for knowledge of "chemistry" or "algebra" provides little guidance. Progress can only be made in this area through collaboration between industry personnel and teachers and leaders from the various discipline-based communities.

Generic, Process, or SCANS Skills

The previous sections discussed the industry content of the academic standards and the academic content of the industry skill standards. This section will look at the extent to which both types of standards call for process-oriented skills. This is important because it is in this area where the most overlap between the two types of standards occurs. In workplace applications, these are referred to as SCANS skills (so called because they were developed by the Secretary's Commission on Achieving Necessary Skills) or advanced generic skills (SCANS, 1991; Stasz et al., 1996). The New Standards project (National Center on Education and the Economy, 1997) refers to a similar collection of crossfunctional skills as Applied Learning Skills. Put simply, SCANS emphasizes the ability to solve problems, to find and use information, and to work with others. It does not specify any particular substantive knowledge as a "necessary skill," since the authors envisioned that representatives of specific occupations would establish specific skill requirements for their occupations. SCANS skills include the following five broad "competencies" and three "foundation skills":

Competencies

1. *Resources*: identifies, organizes, plans, and allocates resources
2. *Interpersonal*: works with others
3. *Information*: acquires and uses information
4. *Systems*: understands complex interrelationships
5. *Technology*: works with a variety of technologies

Foundations

1. *Basic Skills*: reads, writes, performs arithmetic and mathematical operations, listens, and speaks
2. *Thinking Skills*: thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons

3. *Personal Qualities*: displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

Although, in most cases, the industry skill standards do not explicitly call for SCANS skills, this conceptualization has been influential in thinking about skill requirements for work. (Current plans for systems developed under the auspices of the National Skill Standards Board do call explicitly for standards that include the SCANS framework.) Each of the seven industry skill standards considered at the conference had some subset of SCANS-like skills. Problem solving and teamwork were the most common. For example, the health care standards listed communication, systems, employability skills (e.g., professional conduct and appearance), ethics, and teamwork in their core standards (Far West Laboratory, 1995, pp. 15-16). EIF standards included "desirable behavior and work habits" such as work ethics and behavior, interpersonal skills, and teamwork (Electronic Industries Association and Electronic Industries Foundation, 1994, p. 2-1). The auto standards focused on how "academic skills" such as reading comprehension, writing, and listening can be used to "verify, identify, and solve problems" (NATEF, 1995, p. 1). Metalworking included decisionmaking, problem solving, group skills, and personal qualities in their list of "knowledge, skills, abilities and other characteristics" (National Tooling and Machining Association, 1994). Bioscience connects the need for employee "attributes" such as accountability, common sense, flexibility, and leadership to its scenarios and problem statements (Education Development Center, 1995). The AEA standards list "thinking skills which include creative thinking, problem solving and decision making, abstract thinking and knowing how to learn" (AEA, 1997 [brochure]).

The academic standards also included sets of skills that sound very similar. The English standards are dominated by process-oriented skills that could easily fit into the SCANS list as the three standards below illustrate:

> Standard #4: Students adjust their use of spoken, written, and visual languages (e.g., conventions, style, and vocabulary) to communicate effectively with a variety of audiences and for different purposes.
>
> Standard #7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, and people) to communicate their discoveries in ways that suit their purpose and audience.

> Standard #8: Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, and video) to gather and synthesize information and to create and communicate knowledge. (NCTE and International Reading Association, 1996, p. 3)

The science standards advocate some fundamental changes in emphasis that are very much consistent with the shift towards a SCANS perspective. Table 1 illustrates this new emphasis on a more "applied" approach to science. For example, instead of instruction focusing on "getting an answer," students are now encouraged to use "evidence and strategies for developing or revising an explanation" for their findings. Understanding scientific concepts and developing abilities of inquiry are now emphasized more than simply knowing scientific fact and information (National Research Council, 1996, p. 113).

Table 1

Less Emphasis on	More Emphasis on
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and the history and nature of science
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Getting an answer	Using evidence and strategies for developing or revising an explanation
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

Source: National Research Council, 1996, p. 113

The mathematics standards also call for a change of emphasis. They call for more active student involvement in constructing and applying mathematical ideas and problem solving as a means as well as a goal of instruction. In addition, the mathematical standards

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emphasize the development of effective questioning techniques that promote student interaction and communication of mathematical ideas both orally and in writing (NCTM, 1989).

Furthermore, the history standards emphasize the development of "historical thinking skills" and "historical understanding" in addition to knowledge of particular historical events. These are defined as follows:

> *Historical thinking skills*: Enable differentiation of past, present, and future time; raise questions; seek and evaluate evidence; compare and analyze historic stories, illustrations, and records from the past; interpret the historical record; construct historical narratives of their own: 1) chronological thinking, 2) historical comprehension, 3) historical analysis and interpretation, 4) historical research capabilities, and 5) historical issues-analysis an decision making.
>
> *Historical understandings*: define what students should know about history of families, their communities, states, nation and world. (National Center for History in the Schools, 1996, p. 2)

Thus, both sets of standards call for strengthening problem solving, teamwork, inquiry, and communication. They emphasize the use of a variety of sources of information to investigate issues and arrive at answers and solutions, and they advocate the use of different means and media to communicate those solutions. Therefore, generic or process skills provide the most explicit area of common ground between the academic and industry skill standards.

Nevertheless, this recognition is only a first step. A great deal of work remains to be done. We already know that context matters in acquiring skills and knowledge in the first place (Perkins & Salomon, 1989), but the precise relationship between generic and specific skills is still a puzzle. And problem solving is a complicated set of skills and processes that vary in different situations (Stasz et al., 1996). Furthermore, while there is some consensus that these skills are important, much more needs to be done to establish appropriate measures and assessments for generic or process skills. The performance criteria developed by the New Standards Project (National Center on Education and the Economy, 1997) to assess student progress in relation to the Applied Learning Skills represents a promising start to this task.

The problem of defining and evaluating cross-functional skills offers many opportunities for academic and industry skill standards developers to work together. First they must continue the work on determining the generic versus specific components of these process skills. Ultimately, these standards will only be meaningful to the extent that they can be assessed, so both academic and industry groups have a large stake in the success of those efforts.

Using Standards To Facilitate the Integration of Academic and Vocational Education

One of the most interesting outcomes of the conference was that many of the participants developed ideas about using the different standards to design curriculum that integrates academic and industry education. Most participants from the academic and vocational areas had previously had almost no contact with those from the other area and many were skeptical about the extent of common ground. Yet many left the conference with the conviction that prior collaboration might have led to valuable improvements in both sets of standards.

To facilitate interaction and stimulate focused thinking, the conference organized the initial half-day session by assigning the participants to work groups according to academic discipline and industry. For example, the developers of the English standards were paired with representatives of the standards for retailing. As a group, they were charged with reviewing each other's standards, discussing strengths and weaknesses, and identifying opportunities for using the standards to promote integrated instruction and curriculum.

Initially, members of both groups were skeptical that this dialogue would yield significant results. In the English/Retailing group, for example, the English teachers doubted that retailing offered any opportunities for serious, high-level academic work. Similarly, the business and marketing teachers had misgivings that the traditional English curriculum could be linked in any substantial way to their objectives. Technical writing and résumé preparation, of course, might provide some opportunities, but these are a decidedly minor emphasis of the high school English curriculum.

However, as the group reviewed and discussed each other's standards, some interesting ideas began to emerge. For example, the English standards call for mastering critical writing that contrasts and compares alternative points of view. The retailing standards expect students to understand alternative approaches to marketing. The retailing teachers, therefore, asked whether having retailing students write an essay contrasting the different marketing strategies of two major corporations—say, Nike and Reebok—would be an acceptable means for addressing the English standard. Without hesitation, the English teachers endorsed that approach, and the group was soon deep in conversation about the potential richness of such a topic.

Similarly, the English standards call for students to read a wide range of literature from a variety of periods and genres. One of the retailing standards specifies that students will discuss and understand the ethical issues surrounding marketing and other aspects of retailing. The English teachers, therefore, asked whether organizing a unit around reading and performing parts of *Death of a Salesman* would address this retailing standard. The retailing teachers enthusiastically embraced this suggestion.

Thus, in a very short time, this group began to mine what was a much richer vein of integrated content and practice than either had initially imagined. Indeed, some of the traditional stereotypes surrounding the mutual regard (or disregard) that academic and vocational teachers have for one another began to break down. Both groups recognized that each possessed unique and important expertise, which when combined could lead to new opportunities for engaging, substantive learning.

This kind of thoughtful interaction between academic and vocational/technical teachers, as well as industry representatives, can elevate substance and practice among both groups. The academic standards become more concrete and accessible to more students; the industry skill standards can be raised well beyond the entry-level focus that has typified most of these efforts to date. Moreover, academic and vocational teachers gain some new respect for each other's substantive domains and instructional practices. Both groups are essential to the success of this process: Neither academic nor vocational teachers can accomplish successful, rigorous integration acting alone.

As was mentioned previously, this interaction resulted in conference participants representing the NCTE leaving the conference with a plan to develop a document to inform

their membership of the use of English/language arts in industry. They are calling for papers that will extend the discussion of the English/language arts standards into the areas of workplace literacy, career education, and school-to-work.

In another case, one representative of a technical industry initially stated that he had very little to discuss with the developers of the history standards. He thought that his interest would be limited to science and mathematics. Nevertheless, after participating in a discussion group focused on the history standards, much to his surprise, he became convinced that the process of historical analysis called for in the history standards was very much the same as the process of analytical problem solving that is required of a skilled technician in his field. Subsequently, he has worked to strengthen and broaden the academic content of his industry-related training and education.

Thus, participants did not leave the conference with the conviction that either academic or industry groups needed to compromise their standards to bring them into closer alignment with the other set. Indeed, it became clear that both sets of standards could be strengthened through closer coordination, and that the standards themselves could be used to develop curricula and projects that integrate academic and vocational instruction.

Since the conference, NCRVE has held several workshops that have used the techniques developed at the conference.[7] Groups of academic and vocational teachers have used existing sets of academic and industry skill standards to develop interesting integrated student projects.

For example, a group of English and science teachers, charged with designing a project that required students to use several examples of good literature while simultaneously mastering a bioscience industry skill standard concerning contamination, designed the following activity. It so happens that a common laundry detergent, Tide, is visible under ultraviolet light. Consequently, one of the science teachers suggested using Tide to simulate a laboratory accident that contaminated the high school. After first period science class, students would go about the rest of their day carrying a small pouch leaking detergent powder. The following day, students would use ultraviolet lights to find, measure, and trace the dispersal of the "contaminant" throughout the high school.

[7] These workshops were organized to help teachers work with curriculum materials presented in the NCRVE publication, *Getting to Work*.

Collecting and analyzing data on the extent and patterns of contamination, students would suggest and evaluate ways to avoid or minimize the consequences of accidental contamination.

As part of this project, the students would also investigate relevant literature. For example, some might read Eve Curie's biography of her mother, Madame Curie, perhaps discussing the risks that researchers unknowingly or knowingly assume in the pursuit of new scientific knowledge. Others might read Richard Preston's *The Hot Zone* and examine the differences and similarities between contamination in their high school and the global spread of deadly viruses or other diseases.

In another group, aiming to integrate mathematics and manufacturing, math teachers and vocational teachers, along with an industry representative from a company manufacturing corrugated boxes, considered the following learning objectives:

- The student will represent and analyze two- and three-dimensional figures using tools and technology when appropriate. The student will describe the characteristics of geometric figures; identify and verify properties of geometric figures; and use transformations to move figures, create designs, and demonstrate geometric properties.

- The manufacturing student will (1) determine sizes, materials, and other requirements; (2) interpret drawing symbols regarding layout, plan, production, and inspection; (3) relate mechanical drawing to a three-dimensional object; and (4) determine system operation from schematics.

The group suggested a project that would challenge students to evaluate the consequences of adopting different kinds of geometric shapes—for example, circles, squares, triangles, and other polyhedrons—in the manufacture of corrugated cardboard and other boxing materials. Why do some shapes perform better than others and under what conditions? Could the students suggest alternatives to current designs and assess their recommendations?

As was the case at the conference, the participants were initially skeptical about this process. But initial skepticism usually gave way to enthusiasm. Thus, the process has been shown to be an effective way to develop exciting student projects but also to demonstrate to

academic and vocational educators and industry representatives how much they have in common and how much they have to gain by working together.

CONCLUSIONS AND FUTURE DIRECTIONS

This report is based primarily on an examination of the relationship between existing sets of academic and industry skill standards. Much of its content was based on the discussion at the NCRVE conference on integrating these standards. The two sets of standards have so far been developed almost entirely independently of each other. Nevertheless, there is some relationship between the two sets, although that relationship is often only implicit. Both academic and industry skill standards could be improved by more collaboration and coordination. The experience at the conference and subsequent workshops shows that even existing standards can be used to develop interesting projects and curricula that integrate academic and vocational instruction.

But despite great potential, there remain serious obstacles to a system of more effective and more coordinated academic and industry skill standards. In this section, conclusions and suggestions are presented in the form of seven recommendations. Each of these recommendations can serve as guidelines for the development of systems of standards. For example, the National Skill Standards Board or state bodies overseeing standards, in their Requests for Proposals and guidelines, could encourage these measures. Each suggestion is also fertile ground for additional research and development.

1. **Promote the continued collaboration among academic and vocational educators and employers both in the development of standards and in the use of standards to develop curricula.**

   Experience during and after the conference indicates that this collaboration is possible and useful. Indeed it is a requirement for effective implementation of all of the recommendations listed below. For many of the participants, the conference was the first opportunity to interact with members of the other "camp" and many were surprised to find how much the groups had in common. This collaboration has several benefits. First, it can improve the accuracy and relevance of the standards, particularly the academic content of the industry skill standards. Second,

when academic standards are divorced from the workplace context, the academic standards miss the motivational and pedagogic benefits that come from being embedded in a broad and coherent application. Collaboration between academic teachers, employers, and workers can help overcome this problem. Third, a better understanding of the workplace could help academic teachers plan curricula that would be both academically sophisticated and more closely related to the needs of the workplace. There was widespread agreement at the conference that teacher internships in business and other forms of exposure to the workplace were an important component of collaboration.

2. **Improve the definition and measurement of the levels of academic skills within the industry skill standards, including more emphasis on differentiating between the standards for entry-level and higher-level jobs within the same area. Ideally, industry skill standards should be able to refer explicitly to appropriate academic standards.**

For the most part, students could learn the academic skills contained in the industry standards short of high school graduation. This was clearest for mathematics, but less obvious for science. Academic skills from the other disciplines were often defined in the industry skill standards in such general terms that no precise level could be discerned.

What is the significance of the low level of academic skills defined in the industry skill standards? At the very least, it gives ambiguous messages to students about academic skills. Employers state that they prefer high school graduates, yet the academic skills that they list can be learned prior to high school graduation. One possibility is that employers do not understand the specific benefits that students gain from high school and are, therefore, incorrectly specifying the academic content of skill needs. This is precisely the type of problem that improved collaboration could address.

Alternatively, it may be that the industry skill standards are indeed accurate for entry-level work. In this case, it is important for students and teachers using the standards to realize that higher-level skills will be necessary for subsequent career advancement. Thus, it is important that standards be expressed in such a way that

they specify the underlying academic and work-related skill base that will be necessary for success in a career path rather than simply in an entry-level job.

In many cases, the academic components of the industry skill standards are stated in such vague and abstract terms that they provide little guidance to educators and students. Thus, defining the academic content of the industry skill standards is an area that clearly needs much more work. One possibility would be for the industry skill standards to make explicit reference to relevant academic standards.

3. **Develop academic standards so that meeting those standards will indicate that a person is able to apply the relevant academic skills outside the classroom in the workplace and in the community, and so that they specify levels of academic achievement.**

Much of the discussion at the conference and in this report was focused on the strengths and weaknesses of the industry skill standards. This is partly because the National Skill Standards Board provides an institutional direction for these standards. The academic standards lack an equivalent national organization that can provide a forum for a general reevaluation. Nevertheless, some implications for academic standards did emerge from the conference. Some conference participants criticized the academic standards for being too focused on skills needed for a student to proceed to the next level of education rather than on the ultimate usefulness of those skills, whether they involve work, cultural activity, or citizenship. Students should only be able to meet standards for a particular academic area if they can apply the academic skills outside of the education system. Embedding some academic standards within industry-related applications through projects or scenarios (to be discussed below) may be one way to make progress in this area.

Although this report has criticized the industry skill standards for calling for rather low levels of academic achievement, some of the academic standards fail to specify levels of achievement. The English standards offer the best example. We have suggested that the industry skill standards refer explicitly to academic standards in defining required academic skills, but this will be impossible if levels are not defined.

4. **Encourage the use of standards to promote the integration of academic and vocational education. Create a clearinghouse for curricula and projects developed through collaborative use of academic and industry skill standards.**

Better coordination between the two sets of standards should be part of a strategy to achieve the broader goal of the integration of academic and vocational education. The experience at the conference demonstrated that the standards can be used to create projects and curricula that bring academic and work-related material together in an interesting manner that does not compromise the level and sophistication of the standards from either area. As we have argued in this report, an integrated approach to teaching and learning can strengthen the academic base of work-related skills and can provide a context and motivation for learning academic skills. In the exercises conducted at the conference and in subsequent workshops, participants were able to develop these integrated projects with standards that were not written with this goal in mind.

One possibility would be to develop and fund a broader program to encourage and facilitate the use of standards to develop curricula and projects using academic and industry skill standards. Material developed in that way could then be collected and disseminated for wider use.

5. **Systematically experiment with different approaches to coordination of the two sets of standards.**

The discussion at the conference suggested that there should be better coordination between academic and industry standard setters. But what form should standards take and how should they be coordinated? No firm comprehensive answer to this question was developed at the conference; nevertheless, several promising alternatives were discussed.

One option is to link existing standards through crosswalks that identify the academic content of different industry or occupational skills. Indeed, among the industry skill standards that we examined, the bioscience and auto technician standards included such crosswalks. These consisted of matrices in which relevant boxes were checked when a given academic skill was used in a particular vocational

task. Participants agreed that crosswalks were useful, but were only a first step. Nevertheless, this approach will not necessarily generate the benefits that could derive from closer coordination in the development of both sets of standards. Crosswalks identify the academic content of industry-related skills and illustrate the use of academic skills in industry contexts, but we have suggested that both sets of standards would be strengthened if the developers worked closely together. This would not necessarily happen if the efforts at integration were limited to the development of crosswalks for existing sets of standards that were developed independently.

A more difficult approach would be to develop scenarios, or complex examples, that make use of academic and generic skills to accomplish realistic tasks within the context of a given industry. The scenarios naturally integrate academic and vocational material and can lead easily to curricula and projects that can be used by teachers. The bioscience standards examined at the conference were presented in the form of scenarios and while there were specific criticisms at the conference of those standards, there was general enthusiasm for the approach.

A more comprehensive approach might be to design the academic and industry skill standards together, combining both industry needs and a more comprehensive view of an academic program, including attention to the academic foundations required for advancement beyond entry-level positions. Thus, for a given industrial or occupational area, educators and employers would design a comprehensive set of standards that would include academic as well as vocational skills. This would not be practical for a very large number of narrow occupations. It would be more feasible for a smaller number of broadly defined industrial or occupational sectors such as those developed by the National Skill Standards Board.[8] In this case, it might make sense for the academic teachers to develop a general framework for

[8] In 1996, the National Skill Standards Board established sixteen economic sectors to be used to develop standards. These clusters are agricultural production and natural resource management; mining and extraction operations; construction operations; manufacturing, installation, and repair; energy and utilities operations; transportation operations; communications; wholesale/retail sales; hospitality and tourism services; financial services; health and social services; education and training services; public administration, legal, and protective services; business and administrative services; property management and building maintenance services; and research, development, and technical services. In 1997, they started the development process by issuing Requests for Proposals for the development of standards in eight of these areas—wholesale/retail sales; manufacturing, installation, and repair; business and administrative services; communications; construction operations; education and training services; financial services; and hospitality and tourism services.

each discipline and then work with representatives from the broad industry groups to develop comprehensive standards for each group. These standards would at least partly incorporate the academic skills within the specific skills and knowledge needed by the industries. Some parts of the academic standards might not be affected, but it may be that the academic standards would evolve as teachers gained insights into how academic skills are actually applied in the workplace. Standards based on broad industry clusters might involve a set of scenarios that could change given different specialties within the clusters.

6. **Use the development of standards and the collaboration among standard setters to refine our understanding of generic (or SCANS) skills and to develop better means to teach and assess them.**

The most overlap was in the area of generic or process skills. Since generic skills vary in different contexts, it is important to go beyond the general descriptions and language of SCANS and understand the nature of generic skills in the different disciplines and industry settings. Without this specific information, it is difficult to translate the need for skills into a process that has meaning and application in the classroom. One productive strategy would be for representatives from the different groups to work together to develop more consistent methods to articulate, measure, and assess generic skills. Attempts to develop a common language and format are particularly relevant here.

7. **Focus on the development of appropriate teaching strategies and associated curricula and materials and on effective ways to prepare teachers to use those strategies.**

Standards can be both a means to define and signal required skills and important teaching tools. The conference was based on the premise that there is great potential in combining academic and vocational education and that standards could play a role in that strategy. Current pedagogy has been organized around compartmentalized curricula that preserve sharp distinctions among the disciplines, between academic and vocational learning, and even among different vocational areas. Neither the integration of academic and vocational education or the development and use of standards have had a strong educational tradition in this country. Combining an integrated educational approach with standards is even less common. While the

conference and the ongoing work in this field have suggested some possible directions, a great deal of work remains to be done to determine the optimal form of the different sets of standards and the best ways to use them for teaching and learning. Therefore, the reforms suggested here are unlikely to have any effect or even to be implemented unless we have a better understanding of the teaching strategies that would be required and unless we develop and use appropriate methods for preparing teachers to use those new teaching strategies. This is certainly an area that could benefit from more research and development. Designing learning environments that support sophisticated applications based on coordinated academic and industry skill standards and preparing teachers to create and use them may be the biggest challenge.

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